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Vertical distribution in soil of earthworms in Sierra del Caurel

1. species and vegetation types

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With one figure

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1. Introduction

The various species of earthworm that may inhabit a given area do not necessarily dwell at the same depths in the soil, and several classifications of earthworms have included depth of habitat among their criteria. LEE (1959), for example, distinguishes litter species, topsoil species and subsoil species, and BOUCHÉ (1971, 1972, 1977a) classifies earthworm species as "épigées", "endogées" or "aneciques". It is also known that juveniles may tend to be found in shallower positions than adults of the same species, showing that preferences may change in the course of the life cycle. A thorough review has recently been published by LEE (1985).

In Spain, virtually no research has hitherto been carried out on the vertical distribution of earthworm species in the soil profile. Data for some of the species found in Spain have been published by ZICSI (1959), ABRAHAMSEN (1972), NORDSTRÖM & RUNDGREN (1974), RUNDGREN (1975), BOUCHÉ (1977b), PEREL (1977), LAVELLE (1979, 1983), WENDORFF (1980), PEARCE (1982, 1983), and POKARZHEVSKIJ & TITISHEVA (1982), but many species have never been studied in this respect and the data for others are very scarce. We have therefore carried out a study of the vertical distribution of earthworms in Sierra del Caurel (Galicia, N.W. Spain) in which the soil beneath various types of vegetation was sampled over 2 consecutive years, the juveniles and adults of each species being distinguished and the species themselves grouped into ecological categories. In this paper we report depthwise distributions under the most representative types of vegetation and in the area as a whole. In other paper we shall deal with seasonal variations and ecological classification.

2. Materials and methods

Sierra del Caurel is located in the south-east of the province of Lugo (Galicia, Spain). Eight sites (chestnut, *Quercus pyrenaica*, holm oak and beech woods, a broom thicket, one meadow on calcareous soil and another over slate, and a river bank) were sampled during each season for 2 consecutive years. To obtain a broader view of the earthworm fauna of the region, on each occasion sampling was also performed at a site with a different type of vegetation (pine, yew and birch woods, a holm oak wood with herbaceous undergrowth, mountain meadow, cultivated land, heather or fluvial beach). Thus 72 samples in all were taken, 64 of them from the 8 sites sampled seasonally and a further 8 from the extra sites. A detailed description of Sierra del Caurel has been published by GUITIÁN *et al.* (1985), and the sites studied are described by MASCATO *et al.* (in press). The main soil characteristics are summarised in table 1.

Sampling was performed by delimiting half a square metre surface; removing the litter and collecting the specimens contained therein; and excavating successively to depths of 5, 15 and 50 cm to obtain (by manual separation) the specimens contained in the 0–5, 5–15 and 15–50 cm layers. The results of sampling were expressed as percentage presence (PP) and percentage distribution by levels (JESUS, 1986), the latter measures being defined by

$$PDNN = 100n_A(0-5)/N_A$$

where $n_A(0-5)$ is the number of individuals of species A found in the 0–5 cm layer and N_A is the corresponding total number of individuals of the species in the sample. This percentage was calculated for each of the levels studied:

Table 1. Parent matter, textural class and mean values of pH, carbon content (C) and C:N ratio (C/N) in soil under each vegetation type

Vegetation type	Parent matter	Textural class	pH	% C	C/N
Chestnut wood	phyllite	loam, silt-loam	4.6	3.56	13.40
<i>Q. pyrenaica</i> wood	phyllite	loam	5.2	9.11	14.22
Beech wood	slate	sandy-loam, sandy-clay-loam	4.8	7.64	13.40
Holm oak wood	calcareus	sandy-loam	7.8	6.38	12.27
Broom thicket	slate	silt-loam	4.7	10.07	12.38
Slate meadow	slate	silt-loam, sandy-clay-loam	5.4	3.94	9.88
Calcareus meadow	calcareus	silt-loam	6.6	4.43	11.08
River bank	calcareus	loamy-sand	7.0	1.22	9.85

surface, 0–5, 5–15 and 15–50 cm and also for the presence (PDNP) and mass (PDNPe), measured with full digestive tube after a month fixation and after leaving the specimens to drain on filter paper for one minute.

3. Results

3.0. General notes

In all, 14 species were detected: *Allolobophora caliginosa* (SAVIGNY, 1826), *A. chlorotica* SAVIGNY, 1826), *A. rosea* (SAVIGNY, 1826), *Dendrobaena madeirensis* (MICHAELSEN, 1891), *D. pygmaea cognettii* MICHAELSEN, 1903, *D. octaedra* (SAVIGNY, 1826), *D. byblica* (ROSA, 1893), *Eisenia eiseni* (LEVINSEN, 1884), *Eiseniella tetraedra* (SAVIGNY, 1826), *Lumbricus friendi* COGNETTI, 1904, *L. rubellus* HOFFMEISTER, 1843, *Microscolex phosphoreus*, (DUGÈS, 1837), *Octolasion cyaneum* (SAVIGNY, 1826) and *O. lacteum* OERLEY, 1885. The data for all these species were included in the analysis of vertical distribution under the 8 main vegetation types (64 samples) (table 2). In analysing the vertical distribution of each species, data from all 72 samples were included, but five species (*D. p. cognettii*, *D. byblica*, *E. eiseni*, *E. tetraedra* and *M. phosphoreus*) were not analysed because they appeared in less than 10% of the samples and few specimens were collected, making any such analysis unreliable. In analysing the global distribution of the pooled earthworm population, data for all 14 species from all 72 samples were used.

For each vegetation type, and for the area as a whole, the parameters PP, PDNN, PDNPe and PDNP were determined for mature individuals, immature individuals and total population of each species and of the pooled species.

3.1. Vertical distribution under each vegetation type

Table 2 gives total numbers and biomass of the individual species, while fig. 1 shows the PDNN and PDNPe of total populations at each site. The PP and PDNP figures are very similar.

Chestnut wood: Earthworms were found in all 4 layers, but with the largest populations between 0 and 15 cm, where *D. madeirensis* and *L. friendi* were especially abundant. The greatest preference for the surface was shown by *D. octaedra*, and the greatest preference for the 15–50 cm layer by *A. caliginosa*.

***Q. pyrenaica* wood:** Only 3 species were detected, *D. madeirensis*, *L. friendi* and *O. lacteum*. Adults were only found in the deepest layer, and immatures mainly at 5–15 cm.

Beech wood: Earthworms were found in all 4 layers, with the largest numbers at the surface. Only one specimen of *A. caliginosa* was found, and only 2 of *L. friendi*. *D. octaedra* and *E. eiseni* appeared mainly in the top 2 layers (surface and 0–5 cm). *D. madeirensis* was well represented in all 4 layers, but with largest numbers in the bottom two. Most of the total earthworm population was found in the surface, though a large percentage of adults also appeared at 15–50 cm.

Holm oak wood: In keeping with the marked absence of epigeic species, no earthworms were found in the surface. The largest percentages appeared at 5–15 cm.

Table 2. Numbers of individuals (N) and mass (Pe) of the total, mature and immature populations of each species from all samples ($8 \times 0.5 \text{ m}^2$) under each vegetation type

Matur.			Immat.		Total		Matur.			Immat.		Total	
N	Pe		N	Pe	N	Pe	N	Pe	N	Pe	N	Pe	
Chestnut wood							Slate meadow						
Ac	1	0.7	2	0.1	3	0.8	Ac	11	9.2	7	0.9	18	10.1
Dm	21	10.8	12	3.0	33	13.8	Ar	23	3.9	4	0.3	27	4.2
Do	1	0.1	1	0.1	2	0.2	Dm	102	45.3	43	5.1	145	50.4
Lf	6	11.3	10	4.1	16	15.4	Do	3	0.2	1	0.1	4	0.3
<i>Q. pyrenica</i> wood							Lf	54	83.4	116	64.9	170	148.3
Dm	1	0.9	5	0.7	6	1.6	Lr	12	6.4	15	6.2	27	12.6
Lf	0	0.0	1	1.5	1	1.5	Oy	1	1.7	1	0.1	2	1.8
Ol	0	0.0	1	0.2	1	0.2	Calcareous meadow						
Beech wood							Ac	27	10.5	18	2.8	45	13.3
Ac	0	0.0	1	0.3	1	0.3	Ah	20	5.4	11	1.7	31	7.1
Dm	14	6.3	3	0.4	17	6.7	Ar	27	6.8	19	1.5	46	8.3
Do	4	0.5	3	0.3	7	0.8	Do	1	0.1	2	0.1	3	0.2
Ee	4	1.3	8	0.7	12	2.0	Dg	0	0.0	1	0.1	1	0.1
Lf	2	12.7	0	0.0	2	12.7	Lf	33	52.3	44	14.2	77	66.5
Holm oak wood							Lr	68	34.6	17	3.5	85	38.1
Dm	3	1.4	8	2.2	11	3.6	Mp	25	0.4	0	0.0	25	0.4
Lf	12	21.8	23	14.3	35	36.1	Ol	36	11.5	4	0.3	40	11.8
Oy	16	21.9	7	1.4	23	23.3	River bank						
Broom thicket							Ac	34	21.0	58	11.7	92	32.7
Ac	0	0.0	1	0.3	1	0.3	Ah	4	1.2	3	0.3	7	1.5
Dm	5	2.4	7	0.7	12	3.1	Ar	5	1.0	4	0.4	9	1.4
Do	8	0.7	6	0.2	14	0.9	Dy	1	0.1	0	0.0	1	0.1
							Et	0	0.0	1	0.1	1	0.1
							Lf	36	64.2	71	28.6	107	92.8
							Lr	3	1.3	6	1.3	9	2.6
							Oy	1	2.3	0	0.0	1	2.3
							Ol	0	0.0	1	0.1	1	0.1

Ac = *Allolobophora caliginosa*; Ah = *A. chlorotica*; Ar = *A. rosea*; Dm = *Dendrobaena madeirensis*; Do = *D. octaedra*; Dg = *D. pygmaea cognettii*; Dy = *D. byblica*; Ee = *Eisenia eiseni*; Et = *Eiseniella tetraedra*; Lf = *Lumbricus friendi*; Lr = *L. rubellus*; Mp = *Microscolex phosphoreus*; Ol = *Octolasion lacteum*; Oy = *O. cyaneum*.

Broom thicket: Specimens were collected from all layers, though adults, whose numbers peaked at 5–15 cm, were absent from the 15–50 cm layer. Numbers of immatures peaked at 0–5 cm. There were 2 main species, *D. octaedra* in the upper layers and *D. madeirensis* in the lower. *A. caliginosa* was accidental.

Meadow over slate: Most specimens were located at 0–5 cm. The greatest preference for the surface was exhibited by *D. octaedra*, followed by *A. rosea*, *L. rubellus* and *D. madeirensis*. *O. cyaneum* had the greatest preference for the deep layers.

Calcareous meadow: The distribution was virtually the same as in the other meadow. *A. chlorotica*, *L. rubellus*, *M. phosphoreus* and *A. caliginosa* preferred the upper layers and *O. lacteum* the lower ones.

River bank: Most adults appeared at 5–15 cm, though there was also a high percentage at 0–5 cm. Immatures were mostly found at 0–5 cm, but were also abundant at 5–15 cm. Greatest preference for the upper layers was shown by *A. chlorotica* and *E. tetraedra* (though very few specimens of the latter were collected), and greatest preference for the lower layers by *O. cyaneum* and *O. lacteum* (both of which were also relatively uncommon) and by *L. friendi* (which was found in all 4 layers).

To sum up, surface species predominated in beechwood, and *Q. pyrenaica* wood had proportionally the largest deep population. At the other sites the largest populations were found in the middle 2 layers (0–5 and 5–15 cm).

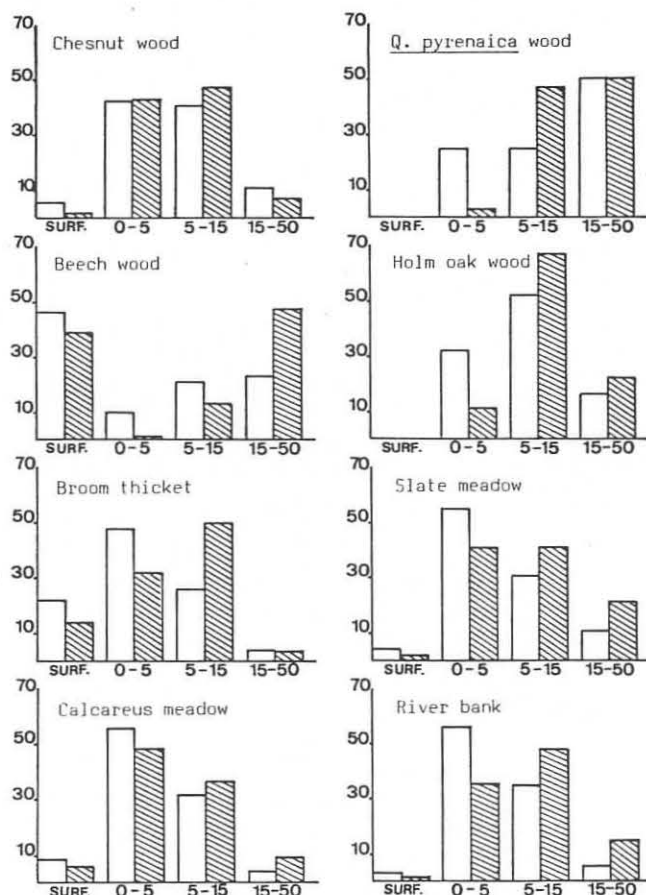


Fig. 1. Percentage distribution by levels for the numbers of individuals (PDNN □) and mass (PDNPe ■) to a depth of 50 cm under each vegetation type.

3.2. Vertical distributions of the species

For each species considered, the various percentages calculated for all the study sites together are listed in table 3.

A. caliginosa was most abundant at 0–5 cm, though also common at 5–15 cm. Immatures were found in all layers, but adults were absent from the top and bottom layers.

A. chlorotica was present in all layers, but adults were absent from the bottom layer and there was a clear preference for the 0–5 cm layer, though large numbers were also found at 5–15 cm.

A. rosea appeared in all layers, though immatures were not found at 15–50 cm. Adults were most abundant at 5–15 cm and immatures at 0–5 cm.

D. madeirensis was also found in all layers, peaking at 0–5 cm but with considerable numbers at 5–15 cm too.

D. octaedra, most common at 0–5 cm, was absent below 15 cm.

L. friendi was uniformly distributed among the 4 layers, though adults preferred the lower layers and immatures the upper ones.

L. rubellus was present only in the top 3 layers, peaking at 0–5 cm.

O. cyaneum was absent from the surface and most common in the deepest, sub-15 cm layer.

O. lacteum was found in all layers, but most commonly at 5–15 cm, showing a general tendency to dwell at greater depths than *A. rosea*.

Table 3. Percentage presence (PP) from all 72 samples and percentage distribution by levels for presence (PDNP), numbers (PDNN) and mass (PDNPe) of individuals for each species, total, matures and immatures

	Total				Matures				Immatures			
	PP	PDNP	PDNN	PDNPe	PP	PDNP	PDNN	PDNPe	PP	PDNP	PDNN	PDNPe
<i>A. caliginosa</i>												
Surf.	7	10	3	1					7	15	4	3
0-5	32	46	72	64	25	49	62	59	25	55	79	75
5-15	28	40	24	35	26	51	38	41	11	24	14	20
15-50	3	4	1	>1					3	6	3	2
<i>A. chlorotica</i>												
Surf.	7	26	18	15	3	14	12	1	6	36	27	27
0-5	13	47	61	62	11	57	63	63	7	45	60	58
5-15	6	21	18	21	6	29	25	25	1	9	7	7
15-50	1	5	3	2					1	9	6	8
<i>A. rosea</i>												
Surf.	3	7	2	2	1	5	2	2	1	6	4	3
0-5	18	43	46	36	13	41	38	33	13	53	63	51
5-15	18	43	48	57	14	45	55	59	10	41	33	46
15-50	3	7	4	5	3	9	5	6				
<i>D. madeirensis</i>												
Surf.	11	11	4	4	7	10	4	4	6	9	4	5
0-5	36	35	57	53	22	33	56	53	25	43	59	50
5-15	40	40	31	34	28	42	32	33	22	38	30	37
15-50	14	14	8	9	10	15	8	10	6	10	7	8
<i>D. octaedra</i>												
Surf.	13	43	41	44	8	46	44	43	8	43	38	47
0-5	11	38	41	41	7	38	44	44	7	36	38	34
5-15	6	19	18	15	3	15	11	13	4	21	25	19
15-50												
<i>L. friendi</i>												
Surf.	17	13	5	3	3	4	1	3	14	14	7	4
0-5	44	34	42	26	19	27	23	22	40	39	51	33
5-15	42	32	38	49	29	40	53	53	38	36	31	42
15-50	28	21	15	22	21	29	23	22	11	11	11	21
<i>L. rubellus</i>												
Surf.	7	21	11	12	6	22	13	14	3	12	5	5
0-5	15	46	67	68	10	39	69	74	14	59	63	45
5-15	11	33	22	20	10	39	18	12	7	29	32	50
15-50												
<i>O. cyaneum</i>												
Surf.												
0-5	3	13	19	8	3	18	22	8	1	14	12	4
5-15	13	60	62	67	8	55	56	67	7	71	75	66
15-50	6	27	19	24	4	27	22	25	1	14	13	30
<i>O. lacteum</i>												
Surf.	1	67	2	2	1	8	2	2				
0-5	4	20	29	38	4	25	31	39	1	20	17	10
5-15	8	40	46	41	7	42	45	41	3	40	50	49
15-50	7	33	23	19	4	25	21	18	3	40	33	41

In general, the earthworm population of Sierra del Caurel were present in all 4 layers considered, with the bulk of the population in the middle layers. Adults exhibited a slight preference for the 5-15 cm layer and immatures for the 0-5 cm layer.

4. Discussion

We are only aware of previous work on earthworm vertical distribution for two of the vegetation types studied, meadow and beechwood.

NORDSTRÖM & RUNDGREN (1974) reported that under permanent pastures and tall herb meadows earthworms appeared at greater depths than under abandoned grasslands, RUNDGREN (1975) that in Swedish meadows earthworms are found down to 75 cm, with greatest abundance at 0–25 cm, WENDORFF (1980) that in various Polish meadows populations peaked at 0–20 cm, and PEARCE (1983) that in English permanent pastures earthworm counts were highest for the 0–5 cm layer. These results are similar to those obtained in the meadows included in the present study. Under this kind of vegetation earthworms appear to spread down to considerable depths if the depth of the soil so allows, but with a predominance of the epigeic and oligohumic endogeic species that occupy the 0–20 cm layer.

Under beechwood, NORDSTRÖM & RUNDGREN (1974) and RUNDGREN (1975) observed a clear predominance of surface-living species. The data for the Sierra del Caurel beechwood corroborate this finding.

We have located no data for the other kinds of vegetation considered in this study. The other vegetation types dealt with in the literature include cultivated and forest soils (AINA 1984), coniferous woods (ABRAHAMSEN, 1972), African savanna (LAVELLE, 1979, 1983), tropical jungle (LAVELLE & KOHLMANN, 1984; NEMETH & HERRERA, 1982), farms (PEARCE, 1982) and various kinds of pinewood, elm, alder and birch woods and heaths (NORDSTRÖM & RUNDGREN, 1974).

The vertical distributions of most of the species considered in the present work have been studied previously, the only exception being *D. madeirensis*, which appears to behave like *A. chlorotica*.

ZICSI (1959) found most specimens of *A. caliginosa* in the top 20 cm of the profile, though the species was also abundant at 20–40 cm, where most inactive individuals appeared. ABRAHAMSEN (1972) found specimens at shallower levels (0–10 cm) and NORDSTRÖM & RUNDGREN (1974) between 0 and 100 cm, with a mean depth of 14.1 cm. BOUCHÉ (1977b) located 86.8 % of the specimens collected in the 0–20 cm layer, RUNDGREN (1975) found the species at between 0 and 25 cm, PEARCE (1982, 1983) collected most specimens at 0–5 cm, and JESUS (1986) at 0–15 cm. *A. caliginosa* is thus widely distributed down the profile, which is not unexpected in a highly polymorphic species whose varieties exhibit differing ecological behaviour.

A. chlorotica was found by ZICSI (1959) chiefly at 0–20 cm, NORDSTRÖM & RUNDGREN (1974) collected 70 % of specimens at 0–5 cm, PEARCE (1982, 1983) found 90 % between 0 and 5 cm, and JESUS (1986) likewise collected the majority of specimens in the upper layers (0–15 cm). Together with the findings of the present study, these data show that *A. chlorotica* lives within the soil but near the surface.

The depthwise distribution of *A. rosea* has been studied by several researchers. ZICSI (1959) found the greatest number of specimens at 0–20 cm, but inactive individuals were commoner at 20–40 cm. NORDSTRÖM & RUNDGREN (1974) found *A. rosea* at an average depth of 17.1 cm, BOUCHÉ (1977b) collected 84.4 % of specimens at 0–20 cm, PEARCE (1982, 1983) observed a preference for the 0–5 cm layer, though with considerable numbers between 5 and 10 cm, and JESUS (1980) collected 50 % at 0–15 cm and 41 % at 15–30 cm. These results generally agree with those of the present study, and show that *A. rosea* tends to occupy appreciably lower layers than *A. chlorotica*.

D. octaedra is reported by ABRAHAMSEN (1972) as being found between 0 and 5 cm; NORDSTRÖM & RUNDGREN (1974) found 88 % of specimens in the top 5 cm, with a mean depth of 3.3 cm. RUNDGREN (1975) found this species exclusively in the 0–5 cm layer, and PEREL (1977) found most individuals at the surface, with a maximum depth of 10 cm. These data agree with those from Sierra del Caurel in showing that *D. octaedra* has a clear preference for the top layer of the soil and is not to be found at depths below 15 cm.

L. friendi was collected by JESUS (1986) at all levels down to 50 cm, with immatures at shallower levels and adults at deeper ones. These findings coincide with the Sierra del Caurel data.

ABRAHAMSEN (1972), NORDSTRÖM & RUNDGREN (1974), RUNDGREN (1975), PEREL (1977)

and PEARCE (1982, 1983) coincided in not finding *L. rubellus* at depths greater than 25 cm, with greatest abundance between 0 and 5 cm. The same distribution was observed in the present work, confirming *L. rubellus* as an epigeic species.

O. cyaneum has been found by JESUS (1986) mainly between 15 and 30 cm, approximately the same depth as in Sierra del Caurel, so that it can be classed as a mesohumic species.

Finally, *O. lacteum* was found by ZICSÍ (1959) between 0 and 60 cm, with a small majority of the active individuals at 40–60 cm. In Sierra del Caurel a preference for the deeper layers was likewise exhibited, though it was also found in shallow layers.

Most researchers have found earthworms almost exclusively in the top 50 cm of the soil, and most species have been found to inhabit the top 20 cm. The data obtained in the present work fit in with this pattern as regards both the various species considered and the earthworm population as a whole.

5. References

- ABRAHAMSEN, G., 1972. Ecological study of Lumbricidae (Oligochaeta) in Norwegian coniferous forest soil. *Pedobiologia* **12**, 267–281.
- AINA, P. O., 1984. Contribution of earthworms to porosity and water infiltration in a tropical soil under forest and long-term cultivation. *Pedobiologia* **26**, 131–136.
- BOUCHÉ, M. B., 1971. Relations entre les structures spatiales et fonctionnelles des écosystèmes, illustrées par le rôle pédobiologique des vers de terre. In: DELAMARE DEBOUTLEVILLE (ed.), *La vie dans les sols*, 189–209. Gauthier Villars, Paris.
- 1972. *Lombriciens de France. Écologie et systématique*. Ann. Zool. Ecol. Anim. Numero hors-serie. INRA, Paris.
- 1977a. Strategies lombriciennes. In: LOHM & PERSSON (eds.), *Soil organisms as components of ecosystems*, Biol. Bull. (Stockholm) **25**, 122–132.
- 1977b. Production et flux d'énergie des lombrics dans les sites du P.B.I. Lab. Zool. INRA, Rouen **4**, 74–94.
- GUÍTIÁN, F., M. T. BARRAL & A. CABANEIRO, 1985. O Caurel. Monografías de la Universidad de Santiago de Compostela **102**.
- JESUS, J. B., 1986. *Lombrices de tierra del Valle del Paular*. Tesis Doctoral. Universidad Complutense de Madrid.
- LAVELLE, P., 1979. Relations entre types écologiques et profils démographiques chez les vers de terre de la Savane de Lamto (Côte d'Ivoire). *Rev. Ecol. Biol. Sol* **16**, 85–101.
- 1983. The structure of earthworm communities. In: J. E. SATCHELL (ed.), *Earthworm ecology from DARWIN to vermiculture*, 449–466. London.
- & B. KOHLMANN, 1984. Étude cuantitative de la macrofaune du sol dans une forêt tropicale humide du Mexique (Bonampak, Chiapas). *Pedobiologia* **27**, 377–393.
- LEE, K. E., 1959. The earthworm fauna of New Zealand. N. Z. Dept. Sci. Industr. Res. Bull. **130**.
- 1985. *Earthworms. Their ecology and relations with soils and land use*. Academic Press, 411 pp.
- MASCATO, R., S. MATO, D. TRIGO, F. MARIÑO & D. J. DIAZ COSIN, (in press). Estudio comparado de las relaciones de las lombrices de tierra con algunos factores del suelo en dos zonas de Galicia (N. W. de España). *Rev. Ecol. Biol. Sol*.
- NEMETH, A., & R. HERRERA, 1982. Earthworm populations in a Venezuelan tropical rain forest. *Pedobiologia* **23**, 437–443.
- NORDSTRÖM, S., & S. RUNDGREN, 1974. Associations of lumbricids in Southern Sweden. *Pedobiologia* **13**, 321–326.
- PEREL, T. S., 1977. Differences in lumbricid organization connected with ecological properties. *Ecol. Bull. (Stockholm)* **25**, 56–63.
- PEARCE, T. G., 1982. Recovery of earthworm populations following salt-water flooding. *Pedobiologia* **24**, 91–100.
- 1983. Functional morphology of lumbricid earthworms, with special reference to locomotion. *J. Nat. History* **17**, 95–111.
- POKARZHEVSKIJ, A. D., & N. G. TITISHEVA, 1982. The population dynamics of the earthworm *Eisenia nordenskiöldi* in meadow steppe habitats in the USSR. *Pedobiologia* **23**, 266–267.
- RUNDGREN, S., 1975. Vertical distribution of lumbricids in Southern Sweden. *Oikos* **26**, 299–306.
- WENDORFF, A., 1980. Numbers, biomass and vertical distribution of earthworms of the pastures in regions of Kraków and Jaworki. *Acta Agraria et Silvestria* **19**, 209–216.
- ZICSÍ, A., 1959. Faunistisch-systematische und ökologische Studien über Regenwürmer Ungarns. II. *Acta Zoologica* **5**, 401–448.

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The vertical distribution of earthworm species in the soil of Sierra del Caurel (Galicia, N.W. Spain) has been studied by seasonal sampling over 2 years. The soil under each of the 8 most representative vegetation types in the area was sampled throughout this period. The vertical distribution of each earthworm species beneath each vegetation type and in the area as a whole were studied, together with the vertical distribution of the earthworm population as a whole without distinction of species. To establish the distributions, 4 soil layers were distinguished: surface, 0–5 cm, 5–15 cm and 15–50 cm.

Surface species predominated in beechwood, and *Quercus pyrenaica* wood had proportionally the largest deep-dwelling populations. At the other sites the largest populations were found in 0–5 and 5–15 cm layers. Adults exhibited a slight preference for the 5–15 cm layer and immatures for the 0–5 cm layer. The vertical distributions of the total population and of the individual species in the area are similar to the distributions recorded for other sites by several authors.

Key words: vertical distribution, earthworms, vegetation.

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